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Index at acceptance:—Classes 1(i), M; 32, A2g2, B3c; and 91, C1g.

COMPLETE SPECIFICATION

Fluid Treating Apparatus and Process for Treating Fluid

I, STANLEY GUSTAV DEHN, M.A., of Kingsway House, 103, Kingsway, London, W.C.2, a British Subject, Chartered Patent Agent, do hereby declare the nature of this invention (a communication to me from BUCKEYE LABORATORIES CORPORATION, a Corporation duly organized under the Laws of the State of Ohio, of 6708, Morgan Avenue, Cleveland, State of Ohio, United States of America), and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to a process and apparatus of selectively separating constituents from a fluid conglomeration.

It has repeatedly been suggested to separate volatilizable constituents from a fluid by heating the fluid until the volatilizable constituents evaporate and then withdrawing the vapors from the residuary fluid. It has also been suggested to effect this application of heat to the fluid to be treated very rapidly as by flashing the heated fluid into a container or by spraying it into a container. The separation of selected constituents, according to the present invention, also is attained by spraying the fluid to be treated into a heated vessel, but the separation by this invention is accurately controlled.

The first step in this invention is to heat the conglomeration of mixed and dissolved fluids, including liquids and gases, preferably under a super-atmospheric pressure. The conglomeration will contain several ingredients which are to be removed (termed the volatilizable constituents), and several to remain as a liquid. Each of the volatilizable constituents will have a different boiling point, even under a sub-atmospheric pressure. To remove all the volatilizable constituents, the one having the highest boiling point under the reduced pressure will control. The conglomeration must be, and remain, at the boiling point of that highest boiling

point constituent under the reduced pressure and the material must be removed as it is volatilized. But the temperature of the conglomeration must not be higher than the boiling point of any constituent to remain.

In theory, if a conglomeration of high and low boiling point constituents is heated under a high pressure to a temperature at least as high as the boiling point under a lower pressure of the highest boiling point constituent to be removed, and then the pressure dropped to the lower pressure, the constituent to be removed should boil off. But in actual practice, such a procedure is impractical. When any liquid volatilizes it absorbs heat and cools the surroundings. Therefore more heat must be added. The devisers of this process have discovered that to heat the original conglomeration high enough to carry sufficient heat of vaporization into the spray chamber will cause deterioration of the liquid constituents, especially in oil purification. They then discovered that if the correct amount of heat were added in the spray zone to just balance the heat absorption, they could control the separation. The volatilized constituents are removed separately from the remaining liquid. The vessel into which the liquid is sprayed encloses a top region and a sump region. The volatilized constituents are removed from the top region and the residuary liquid is withdrawn from the sump region of the vessel. The apparatus of the invention includes, in addition to the vessel containing the spray nozzle, another container, in which the spray vessel is supported and the container holds a heat transfer liquid completely surrounding the spray vessel and heating thereby the spray vessel to a temperature at which condensation of the vaporized constituents of the sprayed liquid is avoided. The vessel into which the spray is discharged is evacuated and the spray region or zone is the upper region in the

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vessel. The gases or vapors produced by the selective separation of the volatile constituents are withdrawn from the top of the spray zone and recovered as volatilized constituents. The heat transfer liquid or fluid may be maintained at the desired temperature by radiant heating means which regulate the thermal energy of the fluid conglomeration to be atomized.

The container for the spray vessel may be arranged with respect to the latter, so that the container surrounds a part of the vessel but not the sump region of the same, and the heat transfer liquid or other heating means for regulating the thermal energy of the vessel, therefore, will be effective on the other portion of the spray vessel only.

According to the invention, therefore, there is provided the process of separating selected volatilizable constituents from a fluid conglomeration into which the volatilizable constituents are dissolved or mixed, comprising the steps of bringing the temperature of the fluid conglomeration to a point which is at least as high as the boiling point, under a high degree of vacuum, of the volatilizable constituents to be removed from the conglomeration, but not as high as the boiling point, under the high vacuum, of the constituents to remain as a liquid, thereafter spray atomizing the fluid conglomeration into a spray zone of a vessel vacuumized to said high degree, and supplying heat to the vessel around the spray zone to compensate for heat absorption and maintain the temperature in the spray zone substantially the same as before the spray atomization, and removing the volatilized constituents and remaining liquid from separate parts of the vessel.

According to another feature of the invention there is provided an apparatus for carrying out the process set forth above, in which a closed vessel contains a spray atomizing means for spraying the conglomeration into a spray zone thereof, including a container within which the vessel is supported, which container has means for supplying thermal energy to and through the walls of said vessel to the said spray zone.

A fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawing, in which:—

Figure 1 is a cross-sectional view of an apparatus embodying the features of the invention and capable of carrying out our process;

Figure 2 is a modification of Figure 1, in that an arrangement for adding a

sweeping agent is added to the equipment;

Figure 3 is a further modification wherein the spray means for the sweeping agent surrounds the spray means for the oil;

Figure 4 is a cross-sectional view of a modified form of an apparatus embodying the features of the invention and capable of carrying out our process;

Figure 5 is a modification of Figure 4, in that a gaseous heating medium is provided;

Figure 6 is a further modification wherein an external heater is provided for independently heating the conglomeration of fluid being sprayed into the apparatus separate from the heating of the chamber;

Figure 7 is similar to the apparatus of Figure 6, but is provided with a gaseous heating medium to surround the inner chamber;

Figure 8 is an external coil jacketed chamber apparatus embodying the features of the invention;

Figure 9 is an internal coil jacketed chamber apparatus embodying the features of the invention;

Figure 10 is a modified form of an external coil jacketed chamber apparatus; and

Figure 11 is a modified form of an internal coil jacketed chamber apparatus.

One of the features of this invention is the provision of heat for the walls of the chamber independently of the heating of the conglomeration to be treated. We have found by experiment that when a heated conglomeration is sprayed into a chamber at sub-atmospheric pressure the walls of which are free to the atmosphere, and consequently maintained at substantially atmospheric temperature, vaporization of the volatile components will occur to a very appreciable extent, and if the fluid is first raised to a temperature sufficiently high to assure enough heat energy for expansion of the conglomeration and latent heat of vaporization of the constituents to be volatilized, it is entirely possible that removal of the constituents to be volatilized will approach completeness. If, however, the vaporized constituents have occasion to come in contact with the walls of the vessel, which are at a much lower temperature, condensation occurs on the walls to an appreciable extent, and the condensed volatile contaminants will flow down the sides of the vessel and combine with the desirable end products which have been free from the volatilized constituents by the fractional distillation which has already occurred. The final result is therefore that the

volatile constituents are removed from the conglomeration being treated and subsequently reincorporated to a considerable degree.

5 Although there has been illustrated one type of apparatus used in carrying out our process, said apparatus is more or less diagrammatic in that other shapes and forms of the inner and outer vessels, 10 as well as other types of spray nozzles and baffle means might be employed. Although in some instances it is desirable to provide an inner evacuated chamber which will be completely surrounded by 15 a heating medium, in other instances it is desirable to provide a chamber the outer surface of which is open to the atmosphere at the bottom in order to provide a sump which is not supplied with 20 heat, to hold the treated material.

It has been found that maintaining the walls in the chamber in the area of the spray and evaporation, that is at the top and upper side portions of the chamber, 25 at an elevated temperature, has contributed substantially to the efficiency of the process. It has been found that the walls of the chamber should be maintained substantially equal to, or slightly above, 30 the temperature of the conglomeration of fluid at the point of introduction into the chamber. By maintaining the walls at a temperature as just described, there are fulfilled two conditions necessary for 35 successful operation. In the first place, for successful operation, there must be no flow of heat from the conglomeration, or from the vaporized volatile portion to the wall. To allow such flow of heat would 40 result in condensation of the volatilized portion with the result that the volatilized portion would be returned to the treated material. Secondly, because a large amount of heat is required to 45 supply energy for expansion of the conglomeration within the chamber and to supply the latent heat of vaporization for the removal of the volatile portion, supplying additional heat to the walls of 50 the chamber to the conglomeration in the region of the spray zone reduces need for heating the original conglomeration to an unduly high temperature in an effort to supply the heat directly to the conglomeration before entering into the 55 chamber, that is, the original conglomeration may be heated to a safe temperature limit before being spray atomized into the chamber, and the additional heat required for the expansion and vaporization is readily supplied through the walls of the chamber as it is required.

60 This invention comprehends the application of the principles explained in a

manner which is efficient and economical. The preferred apparatus employed is shown in the drawings and the process will be understood when reference is made to them while the operation is 70 explained.

As will be seen, apparatus for carrying out one embodiment of the process is illustrated in Figures 1—3 and consists of 75 a means of supplying fluid from a supply vessel 10 by a pump 11 to a chamber 12 in which the fluid, by reason of passage through a spray nozzle 13, is dispersed into exceedingly fine globular particles 80 projected into the space enclosed by the walls 14 of the chamber. The fluid in passing from the pump 11 flows through a series of coils 15 which are immersed in a heat transfer liquid 17 within a container 16. The heat transfer liquid 17 85 is heated in any suitable manner and as illustrated we provide for heating the liquid by means of electric heaters 18 suitably energized from a source of electrical energy. The chamber 12 is main- 90 tained at sub-atmospheric pressure by means of a vacuum pump 19. As illustrated, a condenser 20 is connected between the chamber 12 and the vacuum pump 19 in order to condense the volatile 95 contaminants which are carried off by the action of the vacuum pump 19.

The fluid in passing through the series of coils 15 is heated by the heat transfer liquid before being introduced into the 100 chamber 12. The heat transfer liquid 17, in carrying out one embodiment of our process, also heats the walls 14 of the chamber 12 to a temperature substantially at least as high as the temperature of one 105 fluid which is introduced into the chamber 12 in order to prevent condensation of the vaporized volatile constituents within the chamber 12. The treated fluid is removed from the chamber 12 through 110 a conduit 21 under the action of a pump 22 which delivers the treated fluid to a storage vessel 23. The treated fluid is immediately removed through the conduit 21 from the chamber 12 so that no 115 great accumulation of fluid is present at any time in the chamber 12 to decrease its effective space or capacity. The process may be carried out continuously without interruption and tests show that the 120 process and equipment when treating contaminated oil restore the oil substantially to its original constituency.

Provision is made in Figure 2 for the introduction of a gaseous or vaporized 125 sweeping agent into the treating chamber through a nozzle 25, so that in the fluid being treated advantage may be taken of the well known principle by which such a gas or vapor creates a system of partial 130

pressures of the vapors of distillation and of the gas or vapor inducing or assisting volatilization at temperatures lower than the true boiling point at the given pressure of the hydrocarbons or other volatile contaminating liquids from which the vapors are being produced and have to be removed from the fluid undergoing treatment.

10 In Figure 2 the spray nozzle 13 is located at the top of the chamber 14 and the sweeping agent nozzle 23 is at the bottom. The sweeping agent is heated by passing through a series coil 24.

15 Steam is one of the most common agents used, since it is usually readily available or it may be produced at a source adjacent or contiguous to the chamber in which the distillation is effected. Since the steam must be introduced at a pressure equal to or greater than the pressure of the stream of fluid being supplied, it is not necessary to apply any degree of heat to the steam, since manifestly condensation of water cannot occur in the distillation chamber.

20 In some specific applications, such as for example some hydrocarbon oils used as dielectrics or in various uses in the electric power industry, a special degree of care must be taken to insure that the conditions under which the volatile contaminants are removed are such that no oxidation of the product can occur during treatment. This is true of some special cases in industrial applications in which the types of contamination which are critical may be very specific in character. Oxidation mechanisms leading to the production of low molecular acids, alcohols or aldehydes, and thermal or chemical decomposition producing hydrocarbons of substantially lower molecular weights than those of the normal constituents of the oil. We have

45 employed inert gases, such as for example nitrogen, as sweeping agents in the treatment of contaminated oils to remove the volatile contaminants in several cases in which, either by reason of the composition of the oil or of the contaminants, the product was found to exhibit a degree of sensitivity towards the use of steam, or where it was desired to prevent access of atmospheric air to the product after the volatile contaminants had been removed. In Figure 3, the sweeping agent nozzle 25 surrounds the nozzle 13 so that the oil and the sweeping agent are brought into intimate contact as illustrated.

50 It has also been found that by employing the process herein described, a product is obtained which is equivalent to the original oil in all physical respects, showing complete removal of all volatile

contaminants, and this result is obtained at temperatures very substantially lower than those which are necessary when batch vacuum distillation is used and which are below the critical temperatures for thermal decomposition. Thus, it has been found that diluents which had been introduced into aircraft engine oils in service to the extent of approximately six per cent. of the total volume, and which consisted of volatile hydrocarbons, such as are present in gasoline, together with some low molecular weight oxidation products and water were apparently totally removed by spraying the contaminated oil which had previously been heated to 300° F. into the distillation chamber, which was maintained at a vacuum of approximately 29.6 inches of mercury as referred to a 30-inch barometer, the walls of the chamber also being maintained at 300° F.

The flash point of the aircraft engine oil was 480° when new and the contaminated oil contained a sufficiently high proportion of very volatile hydrocarbons that the flash point was approximately 115° F., and sustained combustion occurred at 155° F. After subjecting the contaminated oil to the process described above, the product had a flash point of 495° F. Similarly, the viscosity of the contaminated oil was very much less than that of the new oil, while the viscosity of the product after treatment was substantially identical with that of the new oil.

Determination of the value for the physical properties usually accepted for evaluation of an oil showed that after the contaminated oil had been fractionally distilled by the process which we have discovered, the product met the requirements outlined in the specifications for new aircraft oil.

110 A series of experiments was made with the same aircraft engine oil in which sweeping agents were used, and in which the direction in which the oil was caused to travel after introduction into the distillation chamber was changed, to determine if changes in the path of travel of the finely dispersed particles in relation to the liquid outlet and the vapor outlet were significant. We have discovered that no appreciable differences were obtained, the final product in every case possessing physical properties closely paralleling those demanded for new oil.

115 While these results show that the limiting conditions for removal of volatile contaminants had been met in every case, to extend the results in the general field of oil contamination, particularly petroleum oil contamination, series of tests 130

were made with an electrical oil, specifically a transformer oil, and with an oil used in the heat treatment of steel.

In the case of the contaminated transformer oil, it was found that the oil before treatment was dark in color, possessed a neutralization value of 0.53 milligram KOH per gram of oil, and a dielectric strength of 7 kilovolts when tested by the standard method of test described by the A.S.T.M. Some sludge was present, and the moisture content was found to be 0.27% by distillation from xylene.

This contaminated oil was subjected to vacuum fractional distillation by the method we have disclosed above, at a temperature of 200° F. and without the use of a sweeping agent. Preliminary to spraying the contaminated oil into the distillation chamber, it was strained to remove solid impurities and aggregations of sludge which would clog the spray nozzle.

The oil collected after subjection to this treatment was then analyzed and the neutralization value was found to be 0.21 mg. KOH per gram of oil, the moisture content was nil by the same method of distillation from xylene, and the dielectric strength was 24 kilovolts. In addition the product was substantially lighter in color than the contaminated oil before treatment. Subsequent filtration may be used, if desired.

The utilization of the process had therefore resulted in the elimination of water and in reduction of the neutralization value of the oil, which can only be ascribed to removal of volatile oxidation products such as carboxylic acids and esters, compounds which are sufficiently active, in a chemical sense to cause deterioration of the equipment in which they may come in contact. The increase in dielectric strength is likewise ascribed to removal of these volatile contaminants, since it is well known that mechanical dispersions of water and the presence in solution of substances relatively rich in oxygen will materially decrease the efficiency of transformer oils and of hydrocarbon dielectrics in general.

With regard to the oil which was used for the heat treatment of steel, it had been discovered in the commercial application for industrial production, that after a certain degree of contamination had occurred, the rate of heat dissipation had been accelerated to the point where surface hardening or "brinelling" was prevalent, and persisted to an extent which either militated against subsequent machine finishing operations, or resulted in the rejection of the steel, because of

failure to meet manufacturing specifications.

The rate of heat transfer is analogous to the rate of transfer of electrical energy in that the same contaminants, and degree of concentration of these contaminants, will affect these properties in like manner, although there may be a difference in the final permissible limits.

The heat transfer oil, or quenching oil, which was used for the experiments herein described, had been rejected as unfit for further use in industry. On analysis, it was found to contain a small amount of free water, and the neutralization value was very much higher than that of the oil originally.

This contaminated oil was heated to a temperature of approximately 250° F., and sprayed into the evacuated distillation chamber, the walls of which were maintained at substantially the same temperature as the oil being treated, and the volatile contaminants vaporized and removed in the vapor form. In some of the experiments, steam was used as a sweeping agent, and it was found that by the use of this sweeping agent, the rate of treatment could be increased to some extent without deleteriously affecting the quality of the treated oil. In all cases, it was possible to produce an oil which possessed physical properties equal to or approximating those demanded in purchase specifications for new oil for the designed application. More significantly, when oil which had been contaminated in service and subsequently subjected to our process as described above was replaced into commercial use, it was found to function in a completely satisfactory manner. While the scientific study of service contamination of quenching oils is not nearly as complete or thorough as similar studies made for electrical and lubricating oil deterioration, a broad survey of the results so far available shows that the progressive formation or incidence of volatile oxidation products and of water, and of extraneously introduced contaminants or catalysts for the production of contaminating products result in a parallel deterioration affecting the quality of the metal products treated therein, and that a limit of usefulness is reached in a sufficiently short period of time. Interruption of production and cost of replacement therefore contribute a substantial portion of production costs for the metal products which have to be subjected to this treatment. When means for treating such oils by our process are provided in conjunction with the heat treating bath, the life of the heat transfer medium has been prolonged to a

period exceeding several times that of mediums used in identical applications but where the treatment has not been made available.

5 It may therefore be stated that in commercial applications of hydrocarbon oils of predominantly petroleum origin, the useful life of such oils varies directly with the rate of accumulation of service
10 contaminants, and that a serious proportion of these contaminants are products of oxidation or thermal decomposition which are substantially more volatile than the hydrocarbon from which they
15 are derived, together with water formed as a product of decomposition or otherwise introduced. If these volatile contaminants are removed totally or are kept below a predetermined critical concentration
20 dependent upon the application, the useful life of these oils may be prolonged to an extent which will greatly affect the economic operation of the equipment in which they are employed, and in addition
25 will reduce substantially the degree to which deterioration products may adversely affect the materials of which the equipment is compounded. The process and apparatus we have disclosed provide a convenient and efficient means for
30 accomplishing the removal of such volatile deleterious agents and are capable of incorporation in a wide variety of useful commercial applications.

35 With reference to the Figure 4, the improved process is carried out by an apparatus which consists of a means of supplying the conglomeration from a supply vessel 10 by a pump 11 to a chamber
40 30 in which the conglomeration, by reason of passing through a spray nozzle 13, is dispersed into exceedingly fine globular particles projected into the space enclosed by the side walls 14 and
45 top 31 of the chamber. This space is referred to as the spray zone. The conglomeration in passing from the pump 11 flows through a series of coils 15 which are illustrated as encircling the chamber
50 30. The chamber 30 is surrounded by a container 32 to provide a space 33 which contains a heat transfer medium and is heated to any suitable desirable temperature, such as by heater rods 18. The heat
55 transfer medium used throughout the illustrated embodiment of the apparatus, and referred to in the description and claims, may be any suitable fluid, either liquid or gaseous. In the embodiment
60 illustrated in the Figure 4, the heat transfer medium is a liquid 17, such for example, as oil. The heater rods 18 may be connected to any suitable electrical supply and they warm the liquid 17 in
65 the space 33 and thus maintain the walls

of the chamber 30 at a temperature at least as high as the boiling point temperature of the highest boiling point constituent of the conglomeration to be removed, at the reduced pressure of the chamber 30 in order to prevent condensation of a vaporized volatile component within the chamber 30.

In this illustrated embodiment of the invention, there is illustrated the container 32 as surrounding the top and side portion of the chamber 30, but we have provided for the bottom of the chamber 30 to extend from the container 32 and be exposed to the atmosphere. Thereby, the treated liquid gathering at the bottom of the chamber 30 prior to being removed therefrom, will not be exposed to continued heating from the heated medium 17 within the space 33. This feature is particularly desirable when treating fruit juices, milk, or other easily disintegrated material. Therefore, the action of the heating, spray atomizing, volatilization, and recondensation is over so quickly that the treated material will not experience a change of composition to affect the taste, color or desirable properties easily affected by prolonged exposure to elevated temperature. The atomized material is indicated by the reference character 34 and is so directed by the spray nozzle 13 that it impinges against the fluid surface exposing device 35 where the atomized material is collected as a thin film and is outwardly dispersed to collect and drip to the bottom of a chamber 30 at a radial distance from the spray nozzle 13.

The treated components are removed from the chamber 30 through a conduit 36 and may be passed through suitable heat exchangers if desired to transfer the physical heat contained therein to a certain extent to the incoming conglomeration. The treated materials may be maintained at a constant level in the sump or bottom portion of the chamber by means of constant level devices or by the rate of pumping from the chamber. Thus, the treated material may be exposed for a further period of time to the low pressure of the chamber, but will be in contact with the unheated bottom portion of the chamber. No accumulation is permitted beyond the bottom region of the chamber 30, whereby the effective space or capacity of the chamber would be decreased. The process may be carried out continuously without interruption, and tests show that process and equipment affords substantially a complete separation as desired.

It is of course understood, that the greatest amount of the surface may be

obtained in the fluid material by spray atomizing the material rather than providing a thin film surface. However, a chamber suitable for spray atomizing a liquid from a relatively high pressure into the chamber held at a relatively low sub-atmospheric pressure, and which would be large enough to permit the spray to ascend as far as possible without striking any surface, would be unduly large and impractical. Therefore, the fluid surface exposing device 35 is used, against which the spray 34 may impinge and be interrupted in its upward direction. In this apparatus, this device 35, we have found, produces the greatest amount of surface area for liquid deposited upon a surface. The device 35 comprises two perforated screen holders 40 and 41 positioned one above the other and containing a multitude of small particles such as Raschig rings, beryl saddles, glass beads or other loose materials including glass wool, mineral wool and steel wool. The device 35 is substantially cone shaped with its apex extending upwardly in the center and the sides extending therefrom toward the side wall 14 of the chamber. Thus, the spray 34 impinges against the device 35 and is there interrupted in its upward path of travel by the multitude of small particles 42. The fluid portion of the conglomeration is thus collected upon the surface of the particles 42 and is continuously moved from one particle to the other outwardly and downwardly by the force of the oncoming spray 34. During the time when the fluid portion of the conglomeration is thus deposited upon the surfaces of the particles 42, it is in a very thin film stage and is continuously exposed to the action of the vacuum within the chamber 30. The small particles 42 provide a ready path for the volatilized constituents to pass therethrough and be exhausted through the condenser 20 and vacuum pump 19.

Other suitable apparatus to carry out the process is illustrated in the Figure 5 of the drawing. In the Figure 5, the space 33 between the chamber 30 and the container 32 is filled with a gaseous medium, such as air. This liquid material serves the same purpose as the liquid 17 employed in the Figure 4. Otherwise, all parts of the apparatus are identical and the process functions in the same manner.

In the Figure 6 of the drawing, there is illustrated a still further modification of the apparatus for carrying out the improved process. In this embodiment, for the coils 15 to preheat the conglomeration before it is introduced into the chamber 30 there are substituted external

heating means. The chamber walls 14 and top 31 are independently heated from a liquid heat transfer medium 17 as previously described. Thus, it is possible to obtain a finer degree of control over the preheating temperature of the conglomeration, and the amount of heat supplied to the chamber walls to the spray zone. That is, a low preheat may be desirable in some fluids, and a high degree of heat supplied to the chamber walls to supply the heat of vaporization and expansion. On the other hand, it may be desirable to provide a greater amount of heat directly to the conglomeration by preheating, and furnishing only enough heat to the chamber walls to maintain the chamber walls at the elevated temperature or to supply a relatively small amount of heat therethrough to the spray zone. In any event, the requisite for carrying out our process in this embodiment of the apparatus is to employ a means of supplying the conglomeration from a supply tank 10 to a supply line 43. The conglomeration is preheated by passing through a heat exchanger 44 and is placed under a relatively high pressure by a pump 11. The conglomeration then progresses to a heater 45 which may be conveniently heated by electrical heating elements of any suitable design, or by steam or other suitable devices if desired. The conglomeration is then introduced into the evacuated chamber 30 by spray atomizing the same through the spray nozzle 13 whereby it is dispersed into exceedingly fine globular particles projected into the spray zone enclosed by the chamber walls 14 and top 31. The chamber 30 is maintained at sub-atmospheric pressure by means of the vacuum pump 19. The treated components are removed from the chamber 30 through a conduit 21 and pass through the heat exchanger 44 where the sensible heat contained therein is transferred to a certain extent to the incoming conglomeration as previously described.

Still another embodiment of a suitable apparatus to carry out the improved process having independent control between the temperature of the incoming oil and the temperature of the chamber walls, is illustrated in Figure 7 of the drawing. In the Figure 7, the space between the container and the external walls of the chamber 30 are filled with a gaseous heat transfer fluid, such for example, as air. This heat transfer fluid serves the same purpose as the liquid 17 employed in the Figure 6. Otherwise all parts of the apparatus are identical and the process functions in the same manner.

In the Figures 10 and 11, there are

illustrated two further modifications of apparatus suitable for carrying out our process. The modifications illustrated in the Figures 10 and 11 are modifications of the Figures 8 and 9 respectively. That is, for use with fluid in which it is desirable to maintain the bottom of the chamber cool and exposed to the atmosphere, there is provided in the Figure 10 for the pipe to surround the chamber by the provision of a steam coil 37 and enclosed by an insulating jacket 38, but the bottom portion of the chamber is exposed. This chamber is illustrated by the reference character 30. The Figure 11, illustrates the coils 37 placed within the chamber 30 with the jacket 38 in direct contact with the outer wall surface of the chamber 30. Other than the described variation and the method of supplying heat to the spray zone of the chamber, all parts of the apparatus are identical with the similar apparatus illustrated in the Figures 6 and 7, and the process functions in accordance with our basic principles.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. The process of separating selected volatilizable constituents from a fluid conglomeration into which the volatilizable constituents are dissolved or mixed, comprising the steps of bringing the temperature of the fluid conglomeration to a point which is at least as high as the boiling point, under a high degree of vacuum, of the volatilizable constituents to be removed from the conglomeration, but not as high as the boiling point, under the high vacuum, of the constituents to remain as a liquid, thereafter spray atomizing the fluid conglomeration into a spray zone of a vessel vacuumized to said high degree, and supplying heat to the vessel around the spray zone to compensate for heat absorption and maintain the temperature in the spray zone substantially the same as before the spray atomization, and removing the volatilized constituents and remaining liquid from separate parts of the vessel.

2. A process, as set forth in claim 1, in which the spray atomization of the fluid conglomeration is effected upwardly.

3. An apparatus for carrying out the process as claimed in claim 1 or 2 in which a closed vessel contains a spray atomizing means for spraying the conglomeration into a spray zone thereof, including a container within which the vessel is supported, which container has means for supplying thermal energy to and through the walls of said vessel to the said spray zone.

4. Apparatus as claimed in claim 3 in which said means for supplying thermal energy comprises a heat transfer liquid within which the vessel is immersed.

5. An apparatus, as set forth in claim 3, including in the closed vessel containing the spray means, a top zone and a sump region, the spray means being located in a spray zone of the top zone and including means for withdrawing the gases from the top of the spray zone to reduce the pressure within the vessel and to remove volatilized constituents of the conglomeration.

6. Apparatus as claimed in claim 3 in which said means for supplying thermal energy are radiant heating means disposed outside the said spray zone.

7. An apparatus, as set forth in any of claims 3 to 6, in which the means in the container supplying heat to the spray zone supplies this heat independently of heat supplied to the conglomeration by external heater means.

8. An apparatus, as set forth in any of claims 3 to 7, including conduit means positioned in the container for conveying the conglomeration to the spray means in the vessel, said conduit means receiving thermal energy from the means in the container which supply thermal energy to the vessel.

9. A method of decontaminating oil by the process set forth in claim 1.

10. A process of selectively separating selected volatilizable constituents from a fluid conglomeration, substantially as described and for the purpose set forth.

11. An apparatus for carrying out the process, substantially as described and shown, and for the purpose set forth.

Dated this 19th day of August, 1946.

For the Applicant,
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London, W.C.2.

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1.

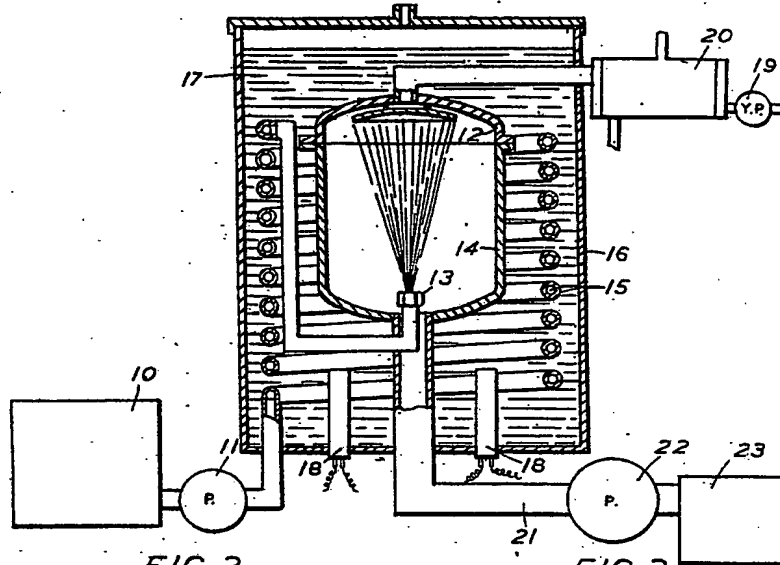


FIG. 2.

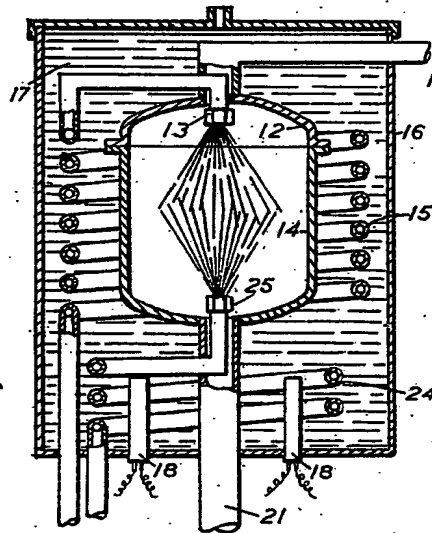


FIG. 3.

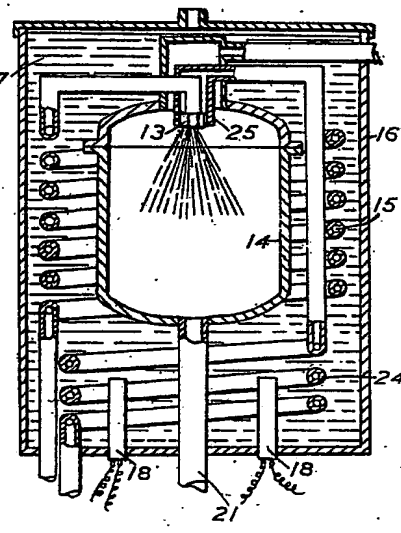


FIG. 4.

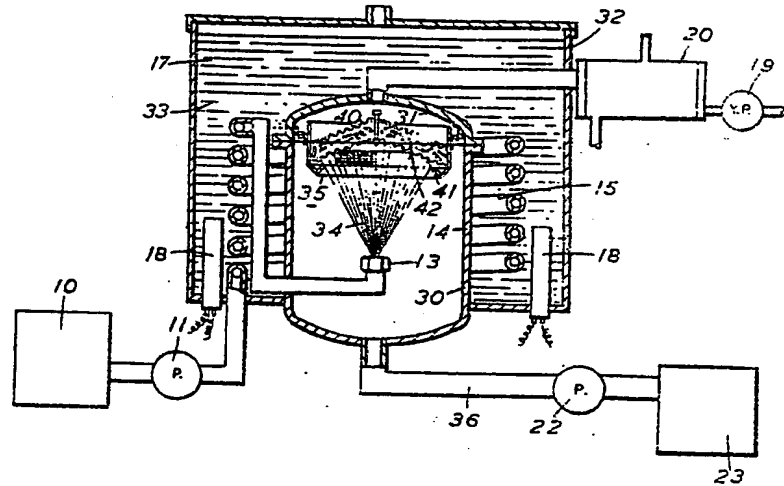
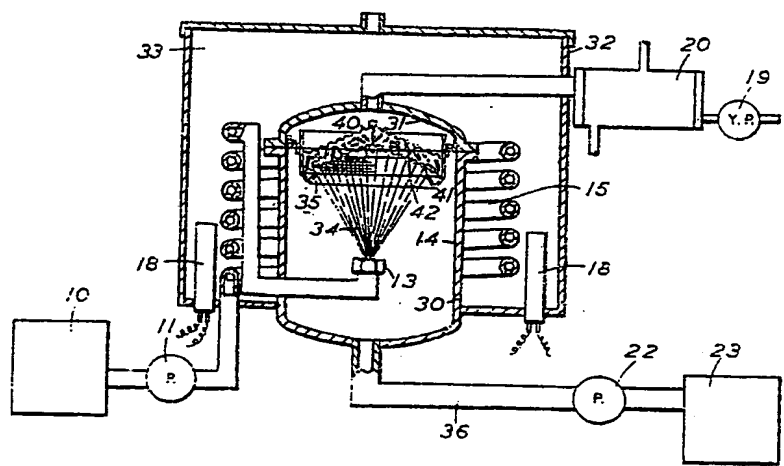


FIG. 5.



[This Drawing is a reproduction of the Original on a reduced scale.]

5 SHEETS
SHEET 3

SHEET 2

SHEET 3

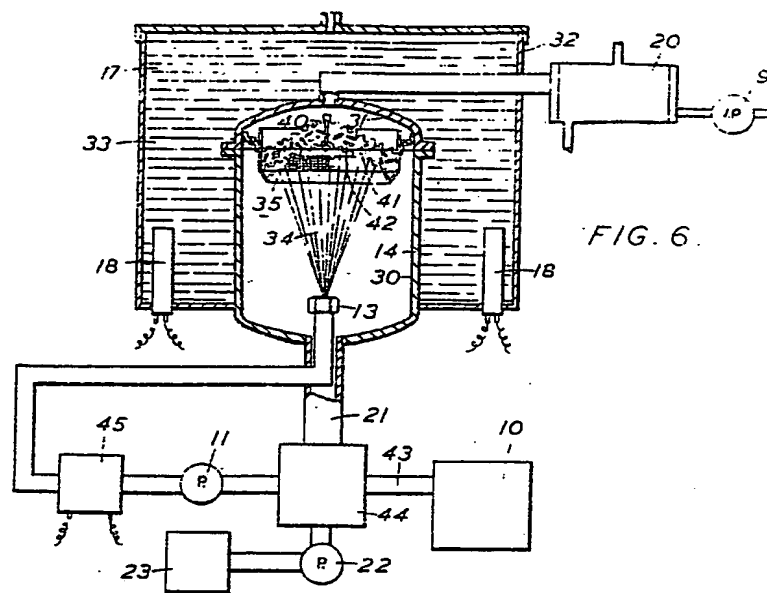
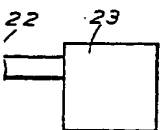
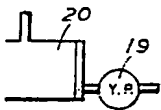
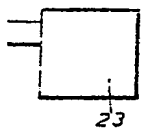
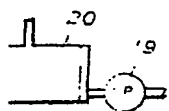
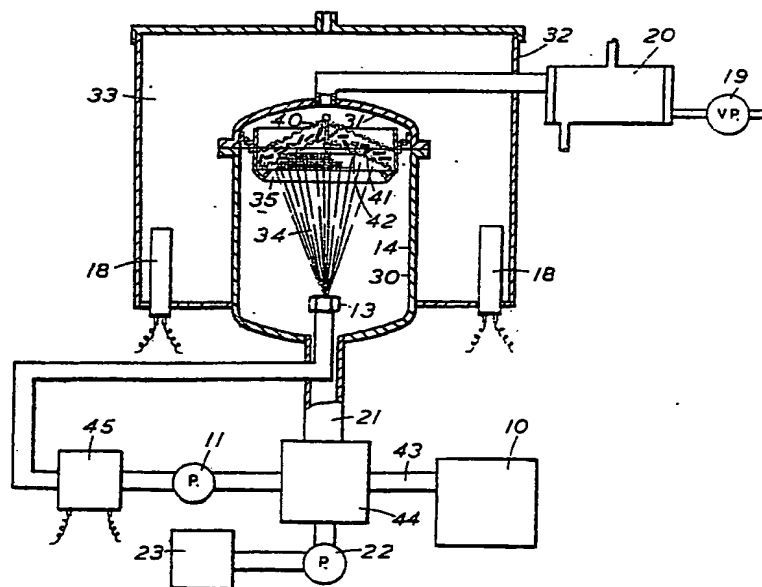


FIG. 6.

FIG. 7.



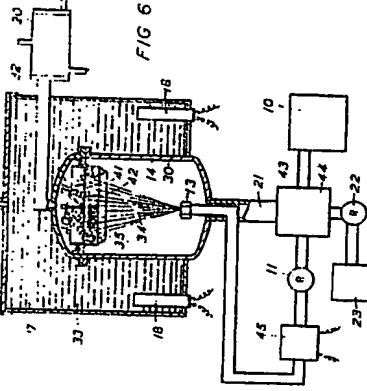
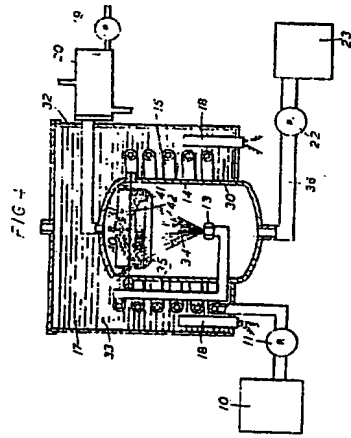


FIG. 5.

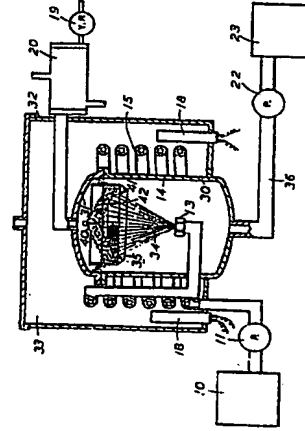
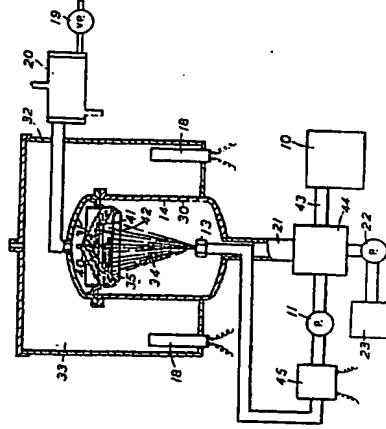
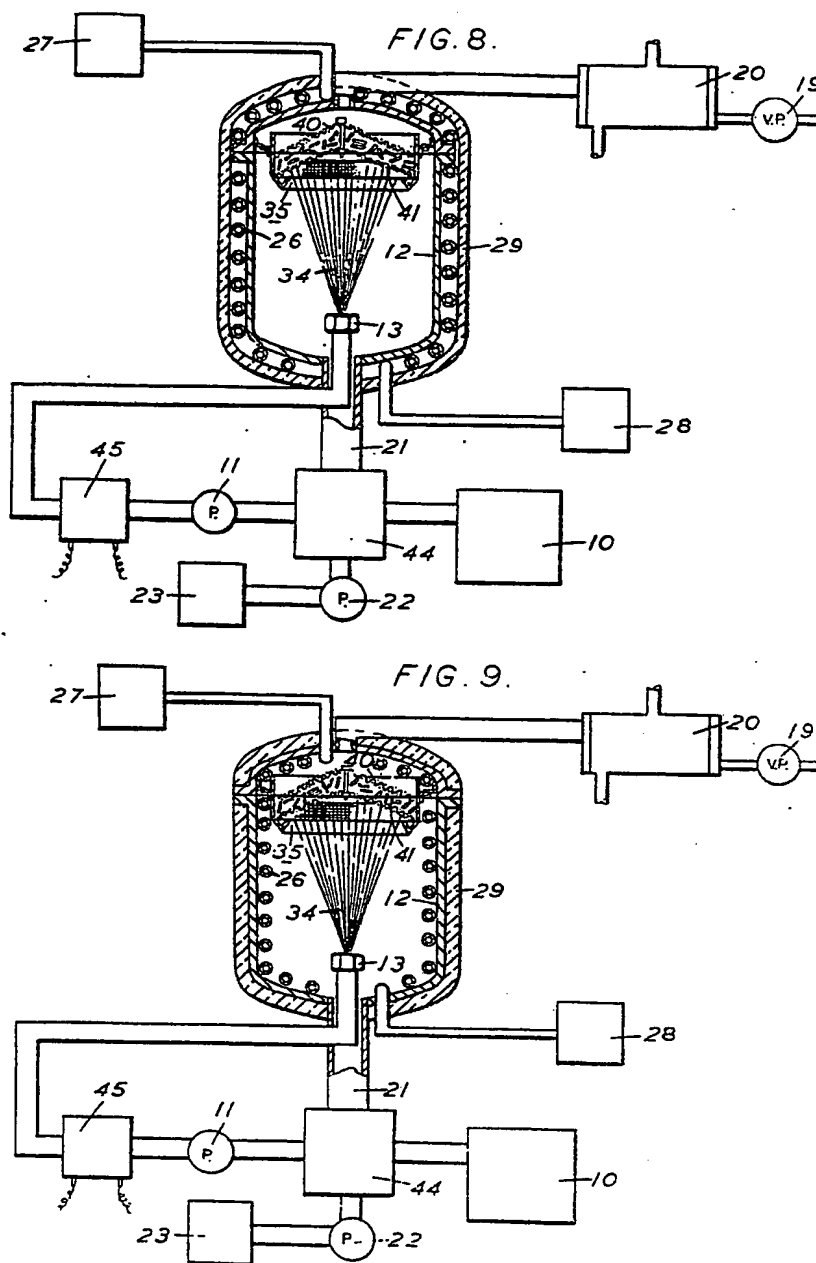


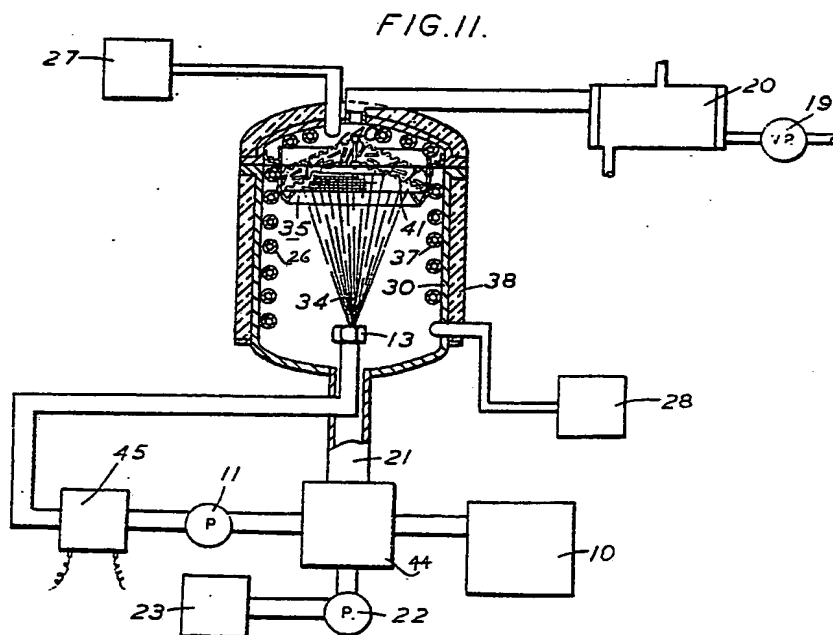
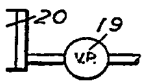
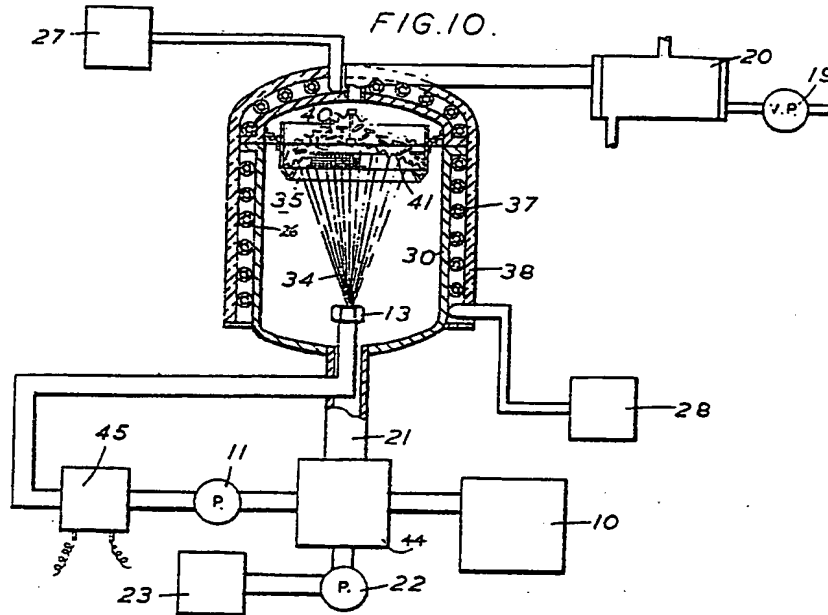
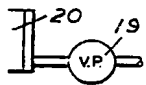
FIG. 7.

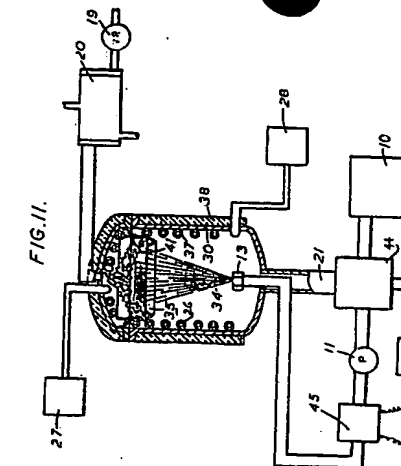
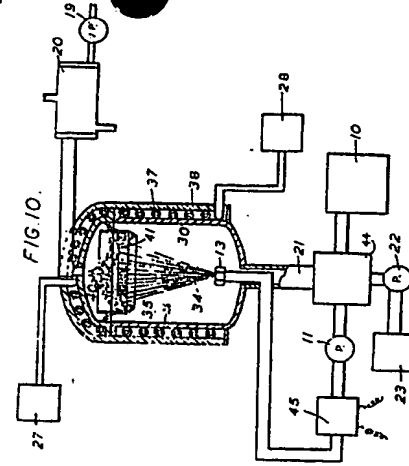
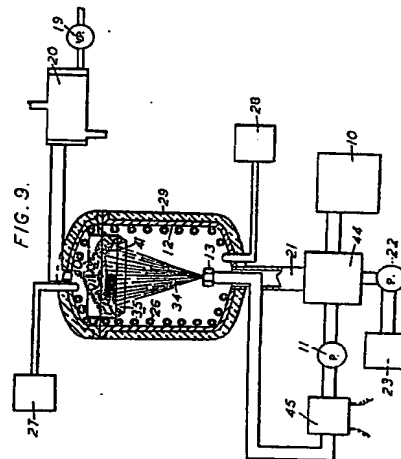
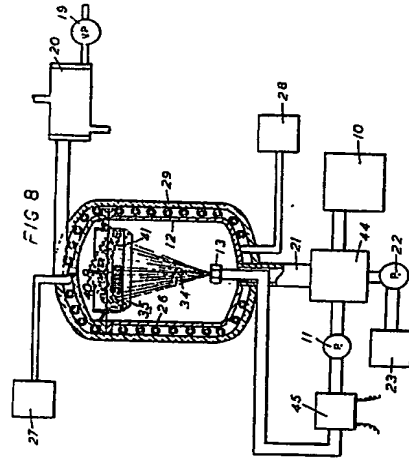


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